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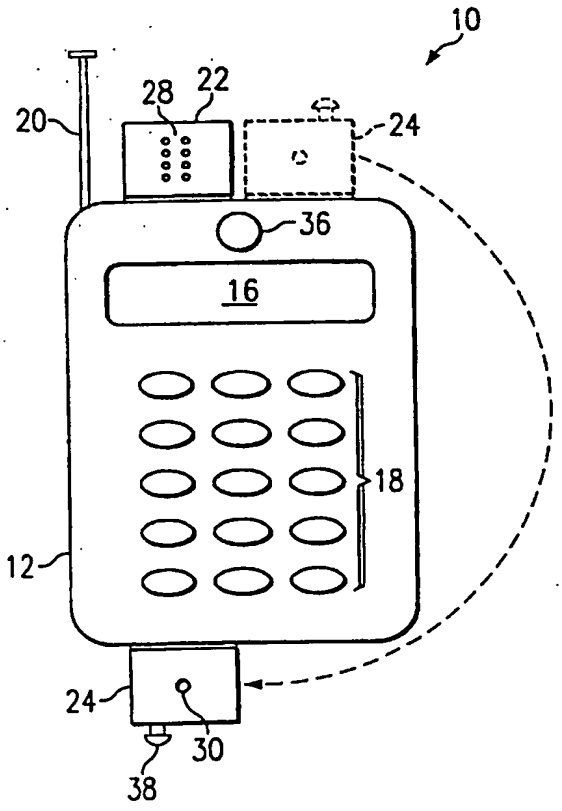
(54) Title: CELLULAR TELEPHONE WITH REDUCED RADIATION EXPOSURE

(57) Abstract

A cellular phone (10) is provided for reducing a user's exposure to RF radiation emitted by cellular phone antennas (20). The phone (10) includes a base unit (12) and a detachably connected handset (14). The base unit (12) includes an antenna (20) for establishing an RF communication link to a wireless communications network. It also includes circuitry for converting RF signals to electrical signals, and electrical signals to RF signals. The handset (14) includes an earpiece (28) and a mouthpiece (30) for receiving and transmitting audio signals to and from a user. It also includes circuitry for converting the input audio signals into electrical signals and electrical signals into output audio signals. The phone is operable in two modes: a standard use mode and a reduced RF radiation exposure mode. In the standard use mode, the base unit (12) and the handset unit (14) are attached and operated as a single unit. Contacts on the base unit (12) engage corresponding contacts on the handset (14) to enable direct electrical transfer of signals between the base unit and the handset. To use the phone in the reduced exposure mode, the handset is detached from the base unit. The base unit is placed a distance of about three feet from the user, and communication between the base unit and the handset is established through an infrared optical communications link.



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CELLULAR TELEPHONE WITH REDUCED RADIATION EXPOSURE MODE

TECHNICAL FIELD

The present invention relates generally to cellular phones and, more particularly, to cellular phones designed to reduce a user's exposure to electromagnetic radio frequency ("RF") radiation emissions from cellular phone antennas.

BACKGROUND OF THE INVENTION

Personal communication devices such as cellular telephones and hand-held radios have proliferated in recent years, and the next generation of these devices is expected to be even more prevalent. While the devices provide users with a convenient means of communication, they raise serious safety concerns, particularly with the users' constant exposure to electromagnetic RF emissions from cellular phone antennas. RF antenna emissions have been reported to be linked to increased risk for head anomalies such as brain cancer.

Several designs have been proposed to reduce electromagnetic exposure from cellular phones. Many of these involve using some type of electromagnetic shield such as those disclosed in U.S. Pat. No. 5,335,366 issued to Daniels, U.S. Pat. No. 5,338,896 issued to Danforth and U.S. Pat. No. 5,336,896 issued to Katz. The Katz patent, for example, discloses an electromagnetic shielded jacket for encasing a cellular phone. Round openings are provided in the jacket adjacent to the earpiece and the mouthpiece to allow sound waves to freely pass. Doors are provided for allowing limited access to the keypad. After a telephone number has been dialed or some other control button depressed, the user can close the door to reduce exposure to radiation emanating from the keypad. Unfortunately, these jackets are cumbersome. They are also not generally compatible with popular flip-phones, in which the mouthpiece is located on a hinged door, which flips to a closed position when not in use to cover the keypad.

Furthermore, while the Katz jacket purportedly shields a user from RF emissions radiating from the phone keypad, a significantly greater health threat has been associated with the much higher emissions radiating from the phone antenna. Katz addresses the antenna issue by installing atop the jacket a telescoping antenna that is hinged at the bottom so that it can be tilted away from the user's head. While this may reduce exposure somewhat to emissions from the tip of the antenna, the base of the antenna remains the same distance from the head. Telescoping antennas are known to emit radiation along their entire length from tip to base. Moreover, when the tip of the Katz antenna is swiveled away from the head, it is inadvertently moved closer to the user's arm, shoulder, back or chest. Thus, the swiveling antenna design accomplishes little more than partially displacing the health risk from one part of the body to another.

Other designs for reducing electromagnetic emissions to the user's head involve modifying the design of the antenna itself. For example, U.S. Pat. No. 5,231,407 issued to McGirr et al. discloses an antenna comprising radiating patch elements enclosed in a portable telephone chassis. The near field of the antenna is configured to reduce radiation exposure to the user's head. Again, while the alternate antenna design might reduce exposure to the head, it inadvertently increases exposure to the user's hand or shoulder. Furthermore, transmission and reception is hindered since a larger part of the user's body absorbs antenna radiation.

In another design (disclosed in U.S. Pat. No. 5,528,689 issued to Alex Y. Chan), a headset is connected to a cellular phone using rubber tubes similar to those used in earlier generation airplane headphones. Apart from sound quality problems, the Chan device is cumbersome. It also reduces cellular phone portability since the user must carry two long rubber tubes and a separate headset when carrying the phone.

Therefore, a need exists for a cellular phone that effectively reduces harmful radiation exposure to the user and that is portable, easy to use, and provides good sound quality.

BRIEF SUMMARY OF THE INVENTION

One object of the present invention is to provide a cellular telephone that significantly reduces harmful radiation exposure to all portions of the user's body.

Another object of the invention is to provide a cellular phone that reduces radiation exposure and is portable and wireless.

A further object of the invention is to provide a cellular phone that reduces radiation exposure and that is easy to use and provides good sound quality.

These and other objects of the invention are achieved by a cellular phone operable in two modes: a standard use mode and a reduced exposure mode. The phone includes a base unit and a detachably connected handset. The base unit includes an antenna for establishing an RF communications link to a wireless communications network. It also includes circuitry for converting RF signals to electrical signals, and electrical signals to RF signals. The handset includes an earpiece and a mouthpiece for receiving and transmitting audio signals to and from a user. It also includes circuitry for converting the input audio signals into electrical signals and electrical signals into output audio signals.

In the standard use mode, the base unit and the handset are attached and used as a single unit. Contacts on the base unit engage corresponding contacts on the handset to enable direct electrical transfer of signals between the base unit and the handset.

To use the phone in the reduced exposure mode, the handset is detached from the base unit. The base unit is placed a distance of about three feet from the user, and communication between the base unit and the handset is established through an infrared ("IR") optical communications link.

In this manner, harmful RF radiation exposure is significantly reduced to all portions of the user's body. In addition, the phone is portable and wireless. It is also easy to use and provides good sound quality.

The foregoing has outlined some of the more pertinent objects of the present invention. These objects should be construed to be merely illustrative of some of the more prominent features and applications of the invention. Many other beneficial results can be attained by applying the disclosed invention in a different manner or modifying the invention as will be described. Accordingly, other objects and a fuller understanding of the invention may be had by referring to the following Detailed Description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference should be made to the following Detailed Description taken in connection with the accompanying drawings in which:

FIGURE 1 is front view of a cellular phone in accordance with the invention in a folded, non-use position;

FIGURE 2 is side view of the cellular phone also in the non-use position;

FIGURE 3 is a front view of the cellular phone in a standard use mode;

FIGURE 4 is a side view of the phone also in a standard use mode;

FIGURE 5 is a view of a user using the phone in a reduced exposure mode;

FIGURE 6 is a schematic block diagram illustrating the digital portion of a cellular phone in accordance with the prior art; and

FIGURE 7 is a schematic block diagram illustrating the IR communication link of the phone in accordance with the invention operating in a reduced exposure mode.

DETAILED DESCRIPTION

FIGURES 1 and 2 illustrate a cellular phone **10** in accordance with the present invention in a folded, non-use position. The phone **10** comprises two detachably connected parts: a base unit **12** and a user interface unit in the form of a handset **14**. (The handset **14** is shown folded in FIGURES 1 and 2.)

The base unit **12** includes a standard LCD display **16** and a control keypad **18**. A telescopic antenna **20** extends from the base unit **12** for cellular RF transmission to a wireless communication network (not shown). The antenna **20** is the source of the radiation for which reduced exposure is desired. The term RF transmission as used in this specification is intended to encompass all transmission frequencies used presently and hereinafter in wireless cellular communication.

The handset **14** comprises two members **22, 24** connected by a hinge **26** such that they can be compactly folded. The member **22** contains an earpiece **28**, and the member **24** contains an mouthpiece **30**. A microphone **32** is positioned at the mouthpiece **30**, and a speaker **34** at the earpiece **28**.

The phone **10** includes a first IR send/receive unit or element **36** located on the base unit **12** and a corresponding second IR send/receive unit or element **38** located on the handset **14** for establishing an IR optical communications link, which will be described in further detail below.

The cellular phone **10** can be operated in one of two modes: a standard mode as illustrated in FIGURE 3 and 4, and a reduced emission mode as shown in FIGURE 5.

The phone **10** is used in the standard mode if the user has no time or sufficient space to use the phone in the reduced exposure mode. To use the phone **10** in the standard mode, the user simply pivots the mouthpiece member **24** of the handset **14** about the hinge **26** into the unfolded position shown in FIGURES 3 and 4. Contacts **40** on the

handset **14** and corresponding contacts **42** on the base unit **12** form switches. When the contacts **40, 42** are engaged (as they would be in standard mode use), communication between the base unit **12** and the handset **14** occurs through direct transmission of electric signals via the contacts **40, 42** (as will be described in detail further below with respect to FIGURES 6 and 7). Thus, in the standard mode, the user holds the phone **10** and uses it in substantially the same manner as any conventional cellular phone.

To use the phone **10** in the reduced exposure mode, the user detaches the handset **14** from the base unit **12**. As shown in FIGURE 5, the base unit **12** is placed a distance away from the user to reduce his or her exposure to RF radiation emitted by the antenna **20**. The user communicates through the handset **14** as he would with any standard telephone handset. A digital IR communications link is established to transmit signals between the handset **14** and the base unit **12** in the reduced exposure mode. When the user detaches the handset **14** from the base unit **12**, the contacts **40, 42** are disengaged, and communications between handset **14** and base unit **12** is switched to the digital IR communications link. The link is established between the IR send/receive unit **38** on the handset **14** and the corresponding IR send/receive unit **36** on the base unit **12**.

The handset infrared unit **38** comprises a pseudo-omnidirectional send and receive unit **44** positioned at the end of a telescopic device **46**. This telescopic device **46** is preferably located on the mouthpiece member **24** of the handset **14**. Its location in the mouthpiece member **24** offers a greater chance of an unhindered line-of-sight communication link between the handset **14** and the base unit **12**. It should be noted, however, that the infrared unit **38** can also instead be positioned on the earpiece member **22** of the handset **14** as indicated in phantom at **48** in FIGURE 5.

In the reduced exposure mode, the base unit **12** of the phone **10** is separated from the user a distance sufficient to significantly reduce

harmful exposure to RF radiation. Radiation strength is inversely proportional to the square of the distance to the source (at least in first order approximation). Therefore, to reduce the radiation level by a factor of 1000 (meaning the exposure would be 0.1% of the original or that radiation would be reduced by 99.9%), the source would have to be moved a distance by a factor of about 32. Since most cellular phones are designed to have their antennas close (about 1 inch) to the user's head, reduction by 99.9% would require a separation distance of about 3 feet.

Unlike RF emissions, the infrared radiation emitted by the IR send/receive units **36, 38** on the handset **14** and the base unit **12** is not known to pose any health hazard.

The phone **10** is battery powered. As shown in FIGURES 2 and 4, the base unit **12** includes a rechargeable battery **49**, and the handset **14** includes a rechargeable battery **51**. The base unit **12** and the handset **14** also include contacts **53, 55** connected to their respective batteries **49, 51**. When the handset **14** and the base unit **12** are attached, the contacts **53, 55** are engaged, permitting both batteries **49, 51** to be simultaneously charged.

FIGURE 6 illustrates in general the functional blocks of a prior art digital cellular phone **100** as specified by the CTIA IS-54 standard. The schematic diagram (from Digital Cellular Phone: A functional analysis by Raj Pawate and Mansoor Chishtie) provides background information for further understanding of the present invention. In brief, a human voice input to a mouthpiece is converted to an analog electric signal by a microphone **102**. The signal is fed through an amplifier **104**, after which it is converted to a digital bit stream in an analog to digital converter **106**. This bit stream is then fed through a speech encoder **108** and a channel encoder **110**. It is then modulated at **112** and filtered for RF transmission from an antenna **114**. Similarly, RF signals received from the antenna **114** are filtered, demodulated at **116**, decoded by a channel decoder **118** and by a speech decoder **120**, converted to an analog signal in a digital to

analog converter **122**, amplified at **124** and output as an audio signal from a speaker **126**.

FIGURE 7 schematically illustrates the infrared communications link of the present invention. The phone **10** of the present invention generally includes the functional components of the digital cellular phone **100** of FIGURE 6. In addition, the phone **10** includes the components for establishing the IR communications link and switches for switching between the IR communications link (when the phone **10** is used in the reduced exposure mode) and the direct electric contact link (when the phone **10** is used in the standard mode).

As shown in FIGURE 7, additional switches **50** and IR send and IR receive units **52, 54** are located between a speech coder **56** and a channel coder **58** in the input path from the mouthpiece **30**. Also, additional switches **60** and IR send and IR receive units **62, 64** are located between the speech decoder **66** and channel decoder **68** in the output path to the earpiece **28**. The IR send unit **52** and the IR receive unit **64** form the send/receive unit **38** on the handset **14**. Similarly, the IR send unit **62** and the IR receive unit **54** form the send/receive unit **36** on the base unit **12**.

The switches **50, 60** are connected to the electric contacts **40, 42** on the base unit **12** and the handset **14**, and are designed to switch to the IR communications link when the contacts **40, 42** are disengaged. When the handset **14** is attached to the base unit **12**, the contacts **40, 42** are engaged, and communication between the handset **14** and the base unit **12** is switched to direct electrical contact through wires **70**. The switches **50, 60** are linked as indicated symbolically by dash line **72** to operate in concert, i.e., they switch between communication links simultaneously.

In the reduced exposure mode, a human voice input to the mouthpiece **30** of the handset **14** is converted to an analog electric signal by the microphone **32**. The signal is fed through an amplifier **74**, after

which it is converted to a digital bit stream in an analog to digital converter **76**. This bit stream is then fed through the speech encoder **56** and thereafter converted to and transmitted as an IR signal by the IR send unit **52**. The signal is then remotely received by the IR receive unit **54** of the base unit **12**. It is converted to an electric signal and fed to the channel encoder **58**. It is then modulated and filtered for RF transmission through the antenna **20** (not shown in FIGURE 7). Similarly, RF signals received from the antenna **20** of the base unit **12** are filtered, demodulated, and then decoded by the channel decoder **68**. The signal is then transmitted optically by the IR send unit **62**. It is received remotely by the IR receive unit **64** on the handset **14** and fed through the speech decoder **66**, converted to an analog signal in the digital to analog converter **78**, amplified at **80** and output as an audio signal from the speaker **34**.

In this manner, the user is isolated from harmful radiation exposure to all portions of his or her body. Thus, the phone **10** enables reduced radiation exposure, yet is fully portable and wireless. It is also easy to use and provides good sound quality

It should be appreciated by those skilled in the art that the specific embodiments disclosed above may be readily utilized as a basis for modifying or designing other devices for carrying out the purposes of the present invention. It should also be realized by those skilled in he art that such equivalent constructions do not depart from the spirit and scope of the invention as set forth in the appended claims.

IN THE CLAIMS

1. A telephone for use in a wireless communications network for isolating a user from telephone radio frequency ("RF") emissions, comprising:

a base unit including:

an RF transmitter for transmitting output RF signals to said network; and

an RF receiver for receiving input RF signals from said network;

a user interface unit including:

a mouthpiece for receiving input audio signals from the user; and

an earpiece for transmitting output audio signals to the user; and

an optical communications link for enabling remote optical communication between said base unit and said user interface unit.

2. The telephone of claim 1,

wherein said base unit further includes circuitry for converting the input RF signals into input electrical signals and for converting output electric signals from said user interface unit into said output RF signals;

wherein said user interface unit further includes circuitry for converting the input audio signals to said output electric signals and for converting input electric signals from said base unit to said output audio signals; and

wherein said optical communications link includes a first element associated with said base unit for optically transmitting said input electric signals from said base unit to said interface unit, and a second element associated with

said user interface unit for optically transmitting said output electric signals from said interface unit to said base unit.

3. The telephone of Claim 1, wherein said user interface unit is detachably connected to said base unit.

4. The telephone of Claim 3, further including a switch responsive to detachment of said user interface unit from said base unit for activating said optical communications link.

5. The telephone of Claim 4, wherein said switch comprises first contacts on said user interface unit and second contacts on said base unit, wherein said first and second contacts are engaged when said user interface unit is attached to said base unit to establish a direct link for transmitting said output electric signals from said interface unit to said base unit, and said input electric signals from said base unit to said interface unit.

6. The telephone of Claim 3, wherein said user interface unit and said base unit include rechargeable batteries that can be simultaneously charged when said user interface unit and said base unit are connected.

7. The telephone of Claim 2, wherein said first and second elements of said optical communications link each comprise an infrared send/receive unit for transmitting and receiving infrared optical signals.

8. The telephone of Claim 2, wherein said circuitry in said interface unit for converting input audio signals to output electric signals includes a microphone.

9. The telephone of Claim 2, wherein said circuitry in said interface for converting input electric signals to said output audio signals includes a speaker.

10. The telephone of Claim 2, wherein said circuitry in said base unit for converting input RF signals into input electrical signals includes a demodulator.

11. The telephone of Claim 2, wherein said circuitry in said base unit for converting output electric signals to output RF signals includes a modulator.

12. The telephone of Claim 1, wherein said user interface unit comprises a handset.

13. The telephone of Claim 12, wherein said handset comprises a first member including said mouthpiece and a second member including said earpiece, and said first and second members are pivotally connected to enable compact folding of said handset.

14. A telephone for use in a wireless communications network for isolating a user from telephone radio frequency ("RF") emissions, comprising:

a base unit including:

an RF transmitter for transmitting output RF signals to said network; and

an RF receiver for receiving input RF signals from said network;

a user interface unit detachably connected to said base unit such that said user interface unit can be detached from said base unit for use of the phone in a reduced emissions mode, and the user interface unit can

be attached to the phone and operable therewith for use of the phone in a standard use mode, said user interface unit including:

a mouthpiece for receiving input audio signals from the user; and

an earpiece for transmitting output audio signals to the user; and

an optical communications link for enabling remote optical communication between said base unit and said user interface unit in the reduced emissions mode.

15. The telephone of claim 14,

wherein said base unit further includes circuitry for converting the input RF signals into input electrical signals and for converting output electric signals from said user interface unit into said output RF signals;

wherein said user interface unit further includes circuitry for converting the input audio signals to said output electric signals and for converting input electric signals from said base unit to said output audio signals; and

wherein said optical communications link includes a first element associated with said base unit for optically transmitting said input electric signals from said base unit to said interface unit, and a second element associated with said user interface unit for optically transmitting said output electric signals from said interface unit to said base unit.

16. The telephone of Claim 14, further including a switch responsive to detachment of said user interface unit from said base unit for activating said optical communications link.

17. The telephone of Claim 16, wherein said switch comprises first contacts on said user interface unit and second contacts on said base unit, wherein said first and second contacts are engaged when said user interface unit is attached to said base unit to establish a direct link for transmitting said output electric signals from said interface unit to said base unit, and said input electric signals from said base unit to said interface unit.

18. The telephone of Claim 15, wherein said first and second elements of said optical communications link each comprise an infrared send/receive unit for transmitting and receiving infrared optical signals.

19. The telephone of Claim 15, wherein said circuitry in said interface unit for converting input audio signals to output electric signals includes a microphone.

20. The telephone of Claim 15, wherein said circuitry in said interface for converting input electric signals to said output audio signals includes a speaker.

21. The telephone of Claim 15, wherein said circuitry in said base unit for converting input RF signals into input electrical signals includes a demodulator.

22. The telephone of Claim 15, wherein said circuitry in said base unit for converting output electric signals to output RF signals includes a modulator.

23. The telephone of Claim 14, wherein said user interface unit comprises a handset.

24. The telephone of Claim 23, wherein said handset comprises a first member including said mouthpiece and a second member including said earpiece, and said first and second members are pivotally connected to enable compact folding of said handset.

25. The telephone of Claim 14, wherein said user interface unit and said base unit include rechargeable batteries that can be simultaneously charged when said user interface unit and said base unit are connected.

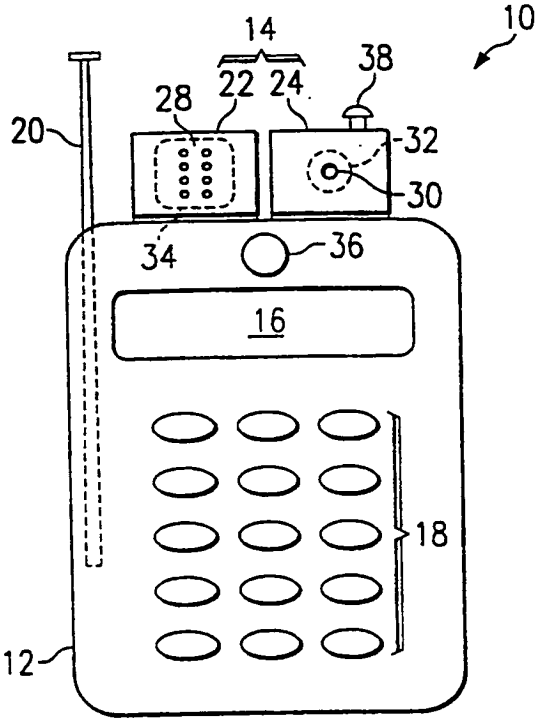


FIG. 1

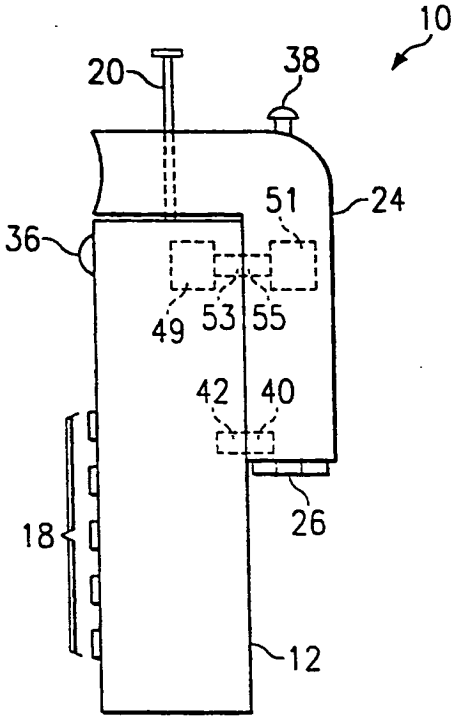


FIG. 2

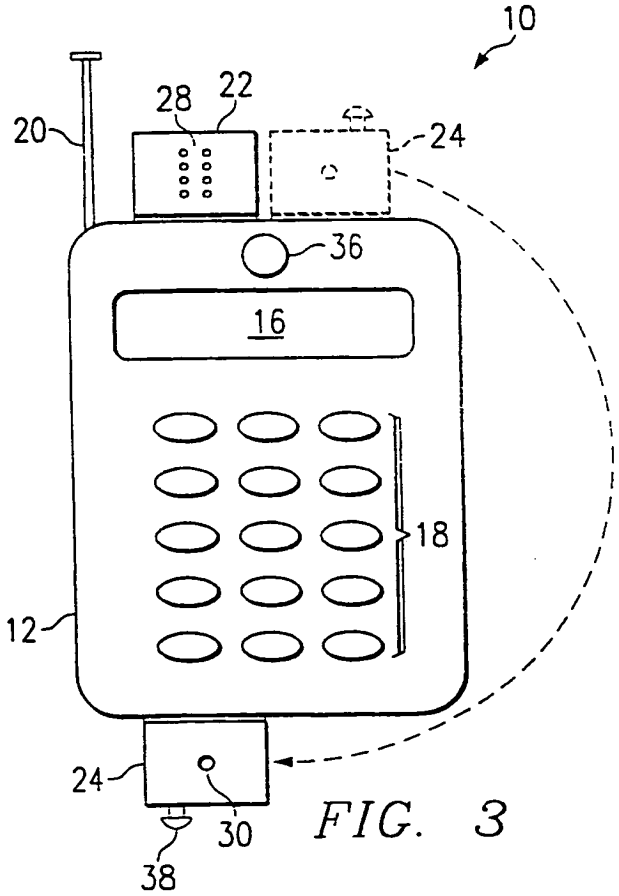


FIG. 3

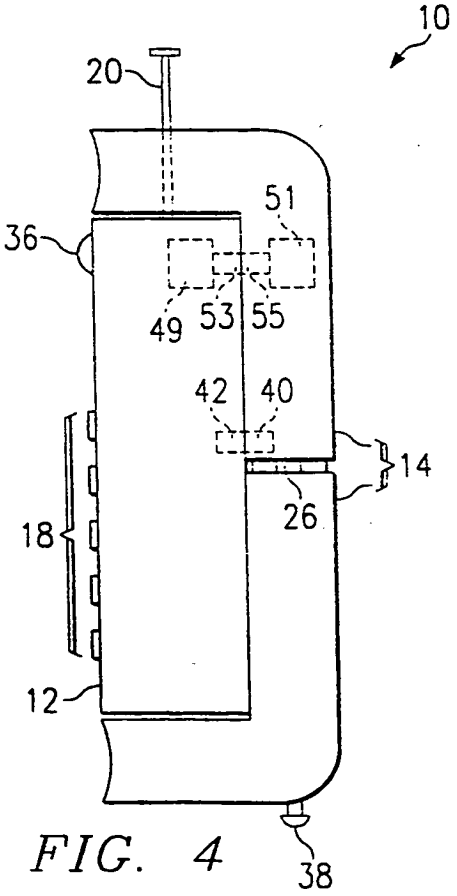


FIG. 4

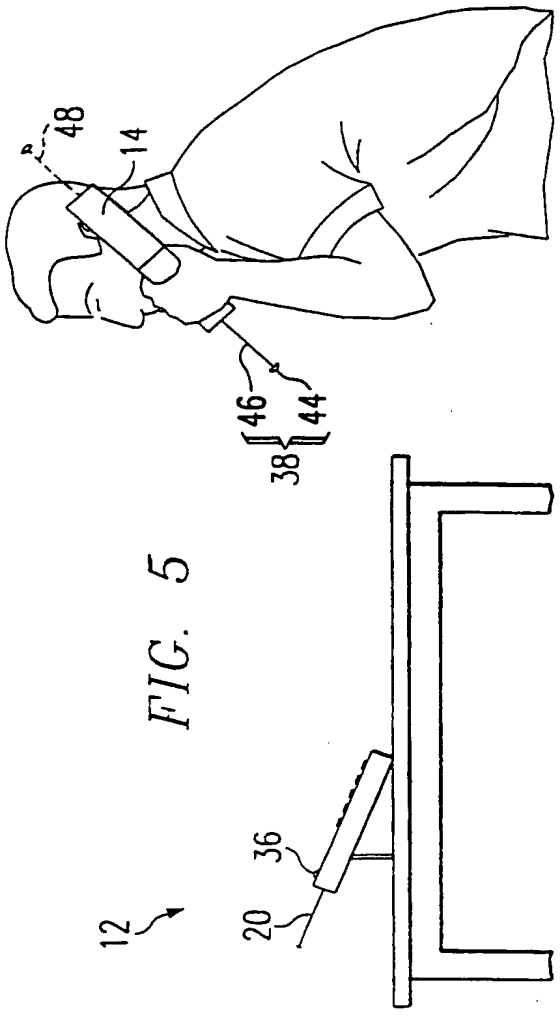
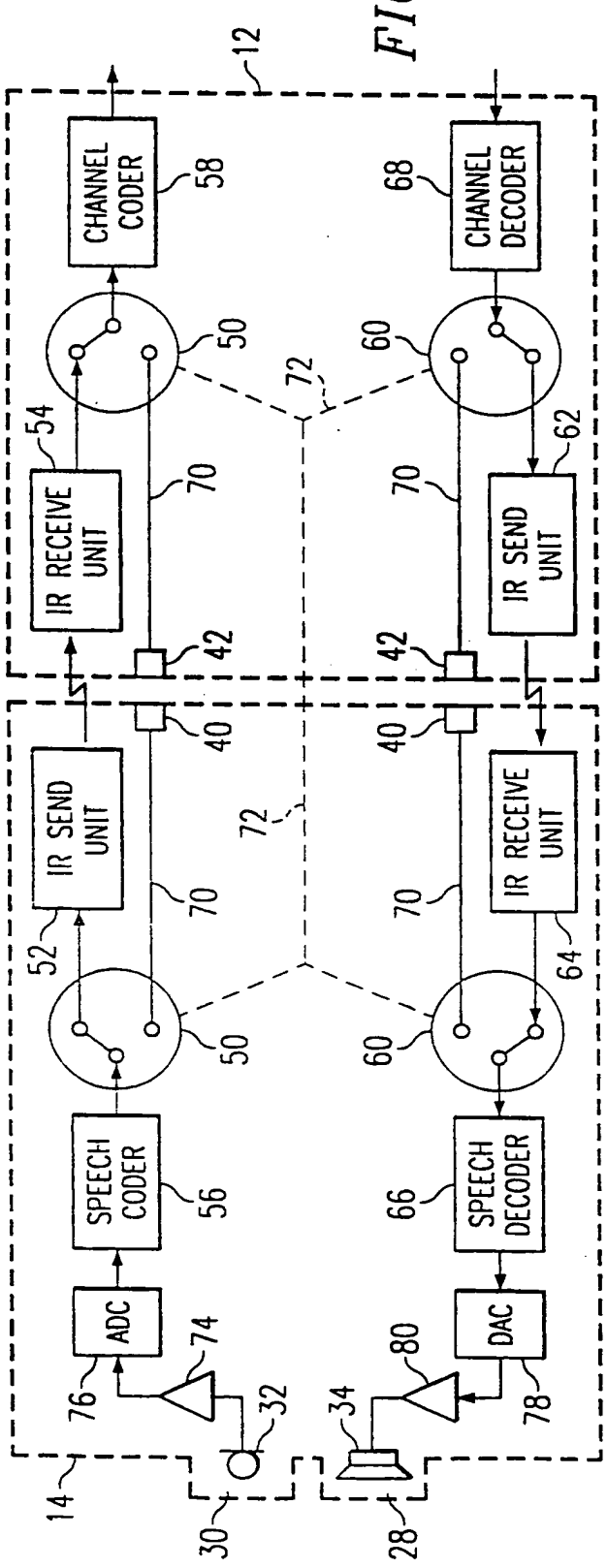

48
14
46
44
38
12
36
20

FIG. 5


12
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CHANNEL DECODER
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IR RECEIVE UNIT
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IR SEND UNIT
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40
IR SEND UNIT
52
IR RECEIVE UNIT
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SPEECH CODER
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SPEECH DECODER
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ADC
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DAC
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28

FIG. 7

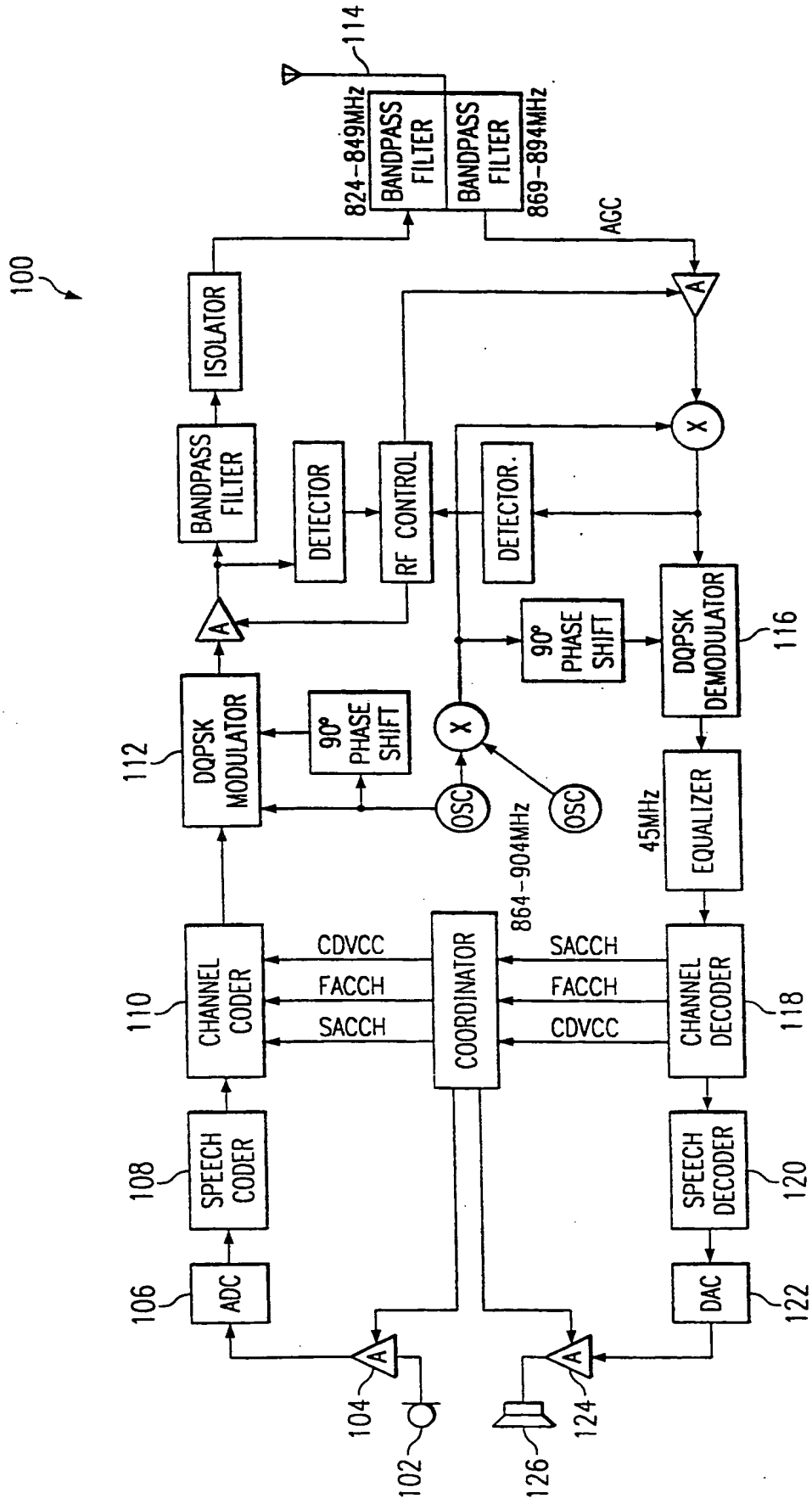

FIG. 6
(PRIOR ART)

CDVCC = coded digital verification color code
DQPSK = differential quaternary phase-shift keying
FACCH = fast associated control channel
SACCH = slow associated control channel

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/05531

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) : H04M 11/00
US CL : 455/117
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/117, 550, 575, 90, 128, 129, 346, 97, 66; 379/420, 433, 428, 56.2, 56.3

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST search terms: radiation, infrared, optical, telphone, phone

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,456,793 A (BAKER ET AL.) 26 JUNE 1984, ABSTRACT AND FIGURE 6	1-25
Y	US 4,775,996 A (EMERSON ET AL.) 04 OCTOBER 1988, ABSTRACT, FIGS. 1 AND 2	1-25
Y	US 4,776,000 A (PARIENTI) 04 OCTOBER 1988, ABSTACT AND FIGURES 1, 3 AND 5	1-25
Y	US 4,882,745 A (SILVER) 21 NOVEMBER 1989, ABSTRACT, FIG. 3, COLUMN 2, LINES 45-53	1-25

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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